SCOPE OF THE CLAIMS

1. An electrolyte membrane having ionic conductivity, the electrolyte membrane comprising:

a base material, and

organic molecules containing ion exchange groups;

wherein the organic molecules are chemically bonded to the surface of the base material to form an organic layer, and

wherein ions are conducted via the ion exchange groups in the organic layer.

2. The electrolyte membrane according to claim 1,

wherein the ion exchange groups include at least one type of functional group selected from phosphonyl, phosphinyl, sulfonyl, sulfinyl, carboxyl, phosphone, phosphine, sulfone, sulfine, mercapto, ether bonding, nitro, hydroxy, quaternary ammonia, amino and phosphoric acid groups.

3. The electrolyte membrane according to claim 1,

wherein the molecular weight of the organic molecules is 10,000 at most.

4. The electrolyte membrane according to claim 1,

wherein the organic molecules are chemically bonded to the surface of the base material by a coupling agent.

5. The electrolyte membrane according to claim 1,

wherein at least one of the organic molecules is chemically bonded to an adjacent organic molecule.

6. The electrolyte membrane according to claim 1,

wherein the thickness of the organic layer is in a range of at least 0.1 nm to at most 500 nm.

7. The electrolyte membrane according to claim 1, wherein the organic layer is a monolayer.

8. The electrolyte membrane according to claim 1, wherein the organic

layer is a bilayer or multilayer that includes a structure in which a plurality of monolayers are built-up.

9. The electrolyte membrane according to claim 1, wherein the base material has at least one form selected from particles or fibres, and wherein the electrolyte membrane includes an amalgamation of the base material.

10. The electrolyte membrane according to claim 1, further comprising:

a porous membrane,

wherein the base material has at least one form selected from particles or fibres, and wherein the electrolyte membrane includes a structure in which the base material is disposed in an inner portion of the holes of the porous membrane.

11. The electrolyte membrane according to claim 1, wherein the base material has a folded film shape.

12. The electrolyte membrane according to claim 11, wherein a surface of the base material and the surface of the electrolyte membrane are perpendicular to each other.

13. The electrolyte membrane according to claim 11, wherein the base material is wound-up.

14. The electrolyte memebrane according to claim 11, wherein the base material is folded into an accordion shape.

15. The electrolyte membrane according to claim 1, wherein the base material is a porous membrane.

16. The electrolyte membrane according to claim 15,

wherein a plurality of through holes that pierce the porous membrane in the direction perpendicular to the membrane surface are formed in the porous membrane; and

wherein the organic molecules are chemically bonded to the inner surface of the through holes, to form the organic layer.

17. The electrolyte membrane according to claim 16,

wherein the cross-sectional area of the through holes that are cut in a direction that is parallel to the surface of the porous membrane changes in the thickness direction of the porous membrane.

18. The electrolyte membrane according to claim 16,

wherein fine holes that are connected to the through holes are further formed in the porous membrane, and

wherein both ends of the fine holes are open ended.

19. The electrolyte membrane according to claim 18, wherein both ends of the fine holes are connected to the through holes.

20. The electrolyte membrane according to claim 18, wherein one end of the fine holes is connected to the through holes and the other end of the fine holes is connected to the surface of the porous membrane.

21. The electrolyte membrane according to claim 1, wherein the base material includes at least one type of material selected from metal, metal oxide, glass, ceramic, clay, carbon, resin and silica.

22. The electrolyte membrane according to claim 21, wherein the base material includes at least one type of material chosen from an oxide of a transition metal, alumina, fluorocarbon resin, aramid resin, silicone resin, amide resin, imide resin and melamine resin.

23. The electrolyte membrane according to claim 1, which includes a plurality of base materials.

24. The electrolyte membrane according to claim 1, wherein the specific surface area per unit volume of base material, measured by gas adsorption method, is at least 100 m^2/cm^3.

25. The electrolyte membrane according to claim 16, wherein when the porosity of the base material is ε (volume %) and the average diameter of the through holes is d (nm), ε and d satisfy the relationship given by $(4 \times \varepsilon) / d > 10$.

26. The electrolyte membrane according to claim 16, wherein when the porosity of the base material is ε (volume %), and the average tortuosity of the through holes is τ, ε and τ satisfy the relationship given by $\varepsilon / \tau^2 < 20$.

27. The electrolyte membrane according to claim 16, wherein in the organic layer, a substance is further provided on the face of the membrane on the side opposite the face that is bonded to the base material so as to fill gaps present in the inner portion of the through holes.

28. The electrolyte membrane according to claim 27, wherein the substance is water-repellent.

29. The electrolyte membrane according to claim 27, wherein the substance is a polymer of at least one type of material selected from organic material and inorganic material.

30. A membrane electrode assembly, comprising:
an electrolyte membrane according to claim 1;
a cathode electrode; and
an anode electrode;
wherein the electrolyte membrane is disposed between the cathode electrode and the anode electrode.

31. A fuel cell, comprising:
an electrolyte membrane according to claim 1;
a cathode electrode; and
an anode electrode;
wherein the electrolyte membrane is held between the cathode electrode and the anode electrode; and further comprising:
a fuel supply portion to supply fuel to the anode electrode, and an oxidizing agent supply portion to supply an oxidizing agent to the cathode electrode.

32. The fuel cell according to claim 31,
wherein the fuel includes at least one type of gas or liquid selected from hydrogen and hydrocarbon.

33. The fuel cell according to claim 32, wherein the fuel includes methanol.